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THE APPLICATION OF RADIOELECTRONICS IN MEDICINE AND BIOLOGY

[Following is a translation of an article by
A. A. Gorodets'kyi and B. R. Kirychyns'kyi in
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Under this designation, two conferences were held in 1959: the All-Union Conference, convened in January in Moscow by the Scientific and Technical Society of Radio Engineering and Electrical Communication imeni O. S. Popov, and the Second International Conference, held in June in Paris under the sponsorship of UNESCO.

The great achievements of contemporary radioelectronics have opened up extensive possibilities for its application in different branches of science and technology, especially in medicine and biology. Unfortunately, work in the branches of biology, medicine, and physiology is carried on without coordination with the work of specialists in radio and electronics, which has been reflected negatively in the application of radioelectronics to the solution of problems in biology and medicine. Hence, the primary theme of both conferences was, on the one hand, familiarization of biologists and therapists with modern developments in radioelectrotechnology in their fields, and, on the other hand, presentation to specialists in the area of radio engineering and electronics of the needs of biology, physiology, and medicine. This accounts for the extensive program of both conferences, which encompassed the diversified fields in medicine and biology.

The head of the Scientific and Technical Society of Radio Engineering and Electrical Communication imeni Popov, Academician Berg, indicated in his opening address the insufficient use of advancements in radio engineering and electronics in medicine and biology. The task involves bringing together scientists of different areas and placing with the radio engineering industry appropriate orders for electronic apparatus for medical and biological purposes.

The director of the International Conference, Prof. Zvorikin, indicated that one of the most important tasks of the conference was to elevate to great scientific heights the studies of biological processes through the use of the achievements of electronics and radio engineering.

About 50 reports were read to the Moscow Conference, and at the Paris meeting, there were about 190 reports and demonstrations in such sections as the following: general medicine, electrophysiological apparatus, new instruments, biochemistry, neurophysiology, manometry, circulation, electroencephalography, respiratory studies, advances in therapeutics, cardiology, oculography, radiology, isotopes, obstetrics and intrauterine pediatrics, and ultrasonics. Such a great number of reports and the diversity of topics prevent a full discussion by us of each separate topic, the more so in that both conferences were accompanied by exhibitions of corresponding interests. Hence, we shall confine ourselves to a general discussion of the extensive possibilities which are opened up by contemporary radioelectro-technology in the different branches of biology and medicine, as revealed by the reports and presentations of both conferences.

As is already known, in physics electronics is the branch of inquiry which studies electronic processes in vacuums, gases, and solid bodies, and also at the interface between two contingent solid bodies. In technology, electronics is the branch which uses electronic and ionic devices, as well as schemes in which such devices are applied.

The entry of electronics into biology and medicine has proceeded along such principal directions as the following:

(a) The application of methods of radioelectronics in the study of biologic structures and of the nature of biologic processes. The method of electronic paramagnetic resonance permits the demonstration of minute traces of free radicals, which is of great importance in radiology. Electron microscopy, which has enabled the achievement of resolving capacities of 10 to 12 angstrom units, has considerably enlarged the possibilities of microscopic studies. Roentgen structural analysis is gradually gaining popularity in the studies of the structure of biological objects.

With the use of X-ray analysis and electron micro-

scopy, it is possible to reconstruct the molecular composition of such complex molecules as nucleoproteins, to extend virologic studies, and to investigate the transmission of inheritable traits.

At the Moscow conference, keen interest was engaged by the report of Bongardt on a model of color vision, which clarifies the mechanism of the visual perception of colors. A demonstration was also given of an electronic apparatus for producing a model of the electrical activity of the heart (Akulinichev and co-authors), which reproduces the arrhythmias observed in pathological conditions of cardiac activity. Considerable discussion was occasioned by a semi-conductor model of the nerve fiber constructed by Liberman.

At the Paris conference, Perkins presented an automatic apparatus which performs roentgenologic studies; in this, the exposure is regulated automatically, providing optimum technical conditions and protecting the investigator against exposure to radiation.

Toll, using various absorption data of radiation by nuclei and cytoplasm of normal and pathologically changed cells, measurements of cells and nuclei, and the method of luminescent microscopy in the investigation of microscopic objects, pointed out the possibility of diagnosing cancer with the aid of electronic apparatus.

Considerable interest was aroused by the report of Tsador, who proposed an electronic apparatus to record the reduced growth of microbes following exposure to various antibiotics.

The use of electronic-computing machines in diagnosis was discussed in the report of Pesh, who recommended recording on a perforated film a duplicated system of information, relating to the patient and to the disease. Deciphering the data of the electronic-computing machine should be combined with a consideration of the data of laboratory, instrumental, and clinical studies. The author recommends confining oneself to a narrow area of diagnostics. He himself practices in the field of ophthalmology.

Reports were also given of data from the Rockefeller Institute (United States) on the use of electronic-computing apparatus for the diagnosis of diseases of the blood. The authors emphasize the necessity of distinguishing between

primary and secondary manifestations of diseases.

(b) Electro-models of processes and phenomena (for instance, functions of the retina of the eye, functions of memory, the electrical activity of the heart, etc.), which may be used for the verification or invalidation of various hypotheses, as well as for pedagogic purposes.

(c) Electrical methods of measuring non-electrical data. Due to the high sensitivity of electronic apparatus, there is an enhanced precision and sensitivity in studies of already-known phenomena and laws. Thus, the use of mechanotrons - electronic tubes with mechanically-regulated grids - has permitted the development of a number of extraordinarily sensitive devices for electronic manometry, sphig-momanometry, phonocardiography, etc., in the objective investigation of sound phenomena in the work of the heart, for pneumotachography in the measurement of the rate of movement of air during respiration, and other devices.

In the report of Jacobson (Sweden), a proposal was made for the use of endoradiosounds, which are inserted into the gastrointestinal tract. Radiosignals from this sound produce different modulations of sound depending on the dose of ionizing radiation. This permits measurement of the dose of radiation received by the internal tissues.

Great interest was evoked by discussion of the radiosound pill. Placed in the stomach, it transmits information on temperature, location, and rate of movement, as well as on the pH of the medium. In pediatric practice, due to the safety of the procedure, such sounding is of great value.

Studies of respiratory noises carried out by Govanian have shown that pathologic changes in the lungs in tuberculosis may be distinguished from respiratory noises in the normal subject with respect to amplitude, frequency, and levelling of the peaks of amplitude waves. Several reports were devoted to the application of radioactive xenon for the study of disturbances in respiratory function.

On the basis of electronic methods of recording, methods and apparatus have been developed for the study of cardiac functions (ballistocardiography, dynamocardiography, electrokimography), for tracing the course of blood in the vessels (electromanometry), for studying the blood supply to different parts of the body (electroplethysmography,

rheography), and so forth.

(d) The development of devices for the application of stimulation - stimulators which produce impulses of any given form and duration.

(e) The development of new directions and methods in diagnostics (electrogastrography).

(f) The use of methods of radioelectronics in roentgenology and radiology. The use of electronic-optical image amplifiers which increase the intensity of illumination of the screen by a factor of 1000 in fluoroscopy, considerably enhancing the possibilities of X-ray studies and, at the same time, reducing the injuriousness of working with X-rays both for the physician and the patient.

Special devices with scintillation counters permit rapid and accurate determinations of the localization of radioactive isotopes in the human organism and in animals, determinations of the total radioactivity of the body, and the use of spectral analysis of radiation of the human body. This permits not only a study of the presence of radioactive elements in the human organism, but also a decision as to which elements are present.

(g) The development of radioelectronic apparatus for the prevention of diseases, especially apparatus for the dosimetry of radioactive, X-ray, ultraviolet, light, and infrared radiations and of high-frequency fields.

(h) On the artificial side - the development of devices for the blind which enable partial compensation for the defects in the visual organs by means of the conversion of light signals to sound signals. Devices for direction by means of prostheses with the use of biocurrents. Hearing apparatus.

(i) Studies of bioelectrical phenomena. The use of modern electronic amplifying apparatus and techniques has considerably extended the possibilities of research in these areas.

(j) The use of methods of television in microscopy for purposes of obtaining black-white and color images of microscopic structures on the television screen (including images in the region of the invisible portion of the spectrum - infrared and ultraviolet), in surgery for teaching

purposes, for demonstration of operations to large groups of students, and so forth.

(k) The development of various devices for laboratory studies, such as devices for the automatic counting of microscopic structures (formed elements of the blood, etc.), miniature radiotelemetric apparatus for the recording of certain physiologic functions (pulse, body temperature, encephalograms, muscle biocurrents, respirations, degree of blood oxygen saturation, and the like).

(l) The use of methods of radioelectronics in physiotherapy.

(m) A considerable number of reports on the tasks which confront radioelectronics in the fields of biology and medicine, and the question of the necessity of combining the efforts of workers in these areas - biologists, therapeutists, physiologists, physicists, and technicians. Hence, the All-Union Conference acknowledged the need for organizing in the USSR, through the auspices of the Scientific and Technical Society of Radio Engineering and Electrical Communication imeni O. S. Popov, a section on medical electronics, the task of which would be to publish reports on new devices and methods of research and investigation, to convene scientific conferences, and to participate in the work of the International Association of Medical Electrical Engineering organized at the Second International Conference in Paris.